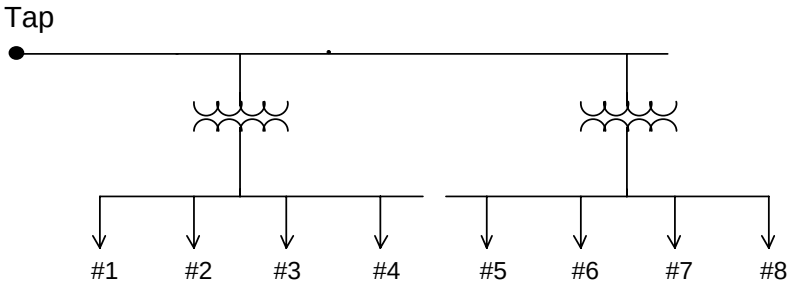
Problem 2.1

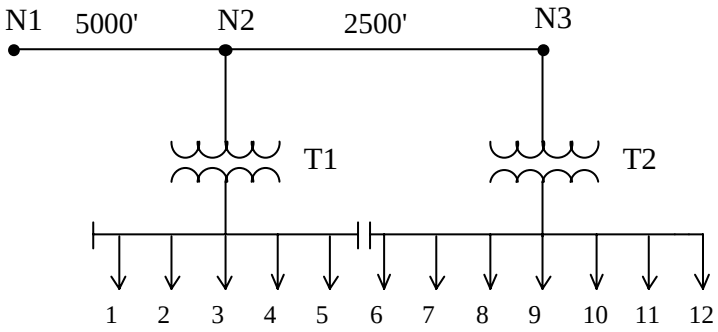
See Excel Worksheet

Problem 2.2



See Excel Worksheet.

Problem 2.3



Problem 2.3.1-2.3.9

See Excel spreadsheet **Answers for 2.3.5, 2.3.6, and 2.3.9 are kW demands**

Problem 2.3.j

$V_{N1} := 2500 \cdot e^{j \cdot 0deg}$ $pf := .95$ $kVA_{T1} := 25$ $kVA_{T2} := 37.5$ $kV_{hi} := 2.4$ $V_{low} := 240$

$z_{line} := 0.306 + 0.6272j$ $zpu_{T1} := 0.018 \cdot e^{j \cdot 40deg}$ $zpu_{T2} := 0.02 \cdot e^{j \cdot 50deg}$

$D_{N1N2} := 5000$ $D_{N2N3} := 2500$

$Z_{baseT1} := \frac{kV_{hi}^2 \cdot 1000}{kVA_{T1}}$ $Z_{baseT1} = 230.4000$

$Z_{T1} := zpu_{T1} \cdot Z_{baseT1}$ $Z_{T1} = 3.1769 + 2.6658j$

$$Z_{baseT2} := \frac{kV_{hi}^{2} \cdot 1000}{kVA_{T2}} \qquad Z_{baseT2} = 153.6000$$

$$Z_{T2} := zpu_{T2} \cdot Z_{baseT2} \qquad Z_{T2} = 1.9746 + 2.3533j$$

$$z_{N1N2} := z_{line} \cdot \frac{D_{N1N2}}{5280} \qquad z_{N1N2} = 0.2898 + 0.5939j$$

$$z_{N2N3} := z_{line} \cdot \frac{D_{N2N3}}{5280} \qquad z_{N2N3} = 0.1449 + 0.2970j$$

Note: The voltage drops will be computed for a "worst case" situation. For each segment or transformer the maximum kVA demand on that segment or transformer will be used to compute the voltage drop to the remote end. This remote end voltage will then be assumed to be the voltage at that node when the maximum diversified demand downstream occurs.

$$kVADemand_{N1} := \frac{57.89}{pf} \cdot e^{j \cdot acos(pf)} \qquad \left|kVADemand_{N1}\right| = 60.9368 \qquad \frac{arg\left(kVADemand_{N1}\right)}{deg} = 18.1949$$

$$I_{N1N2} := \frac{\overline{kVADemand_{N1}}}{\frac{V_{N1}}{1000}} \qquad \left|I_{N1N2}\right| = 24.3747 \qquad \frac{arg\left(I_{N1N2}\right)}{deg} = -18.1949$$

$$V_{N2} := V_{N1} - z_{N1N2} \cdot I_{N1N2} \qquad \left|V_{N2}\right| = 2488.7963 \qquad \frac{arg\left(V_{N2}\right)}{deg} = -0.2658$$

$$kVADemand_{T1} := \frac{22.71}{pf} \cdot e^{j \cdot acos(pf)} \qquad \left|kVADemand_{T1}\right| = 23.9053 \qquad \frac{arg\left(kVADemand_{T1}\right)}{deg} = 18.1949$$

$$I_{T1} := \frac{\overline{kVADemand_{T1}}}{\frac{V_{N2}}{1000}} \qquad \left|I_{T1}\right| = 9.6052 \qquad \frac{arg\left(I_{T1}\right)}{deg} = -17.9290$$

$$V_{T1} := V_{N2} - I_{T1} \cdot Z_{T1} \qquad \left|V_{T1}\right| = 2451.9975 \qquad \frac{arg\left(V_{T1}\right)}{deg} = -0.6196$$

$$V_{lowT1} := V_{T1} \cdot \left(\frac{V_{low}}{kV_{hi} \cdot 1000}\right) \qquad \left|V_{lowT1}\right| = 245.1998$$

$$kVADemand_{N2} := \frac{41.56}{pf} \cdot e^{j \cdot acos(pf)} \qquad \left|kVADemand_{N2}\right| = 43.7474 \qquad \frac{arg\left(kVADemand_{N2}\right)}{deg} = 18.1949$$

$$I_{N2N3} := \frac{\overline{kVADemand_{N2}}}{\frac{V_{N1}}{1000}} \qquad \left|I_{N2N3}\right| = 17.4989 \qquad \frac{arg\left(I_{N2N3}\right)}{deg} = -18.1949$$

$V_{N3} := V_{N2} - z_{N2N3} \cdot I_{N2N3}$ $|V_{N3}| = 2484.7879$ $\frac{\arg(V_{N3})}{\text{deg}} = -0.3619$

$V_{T2} := V_{N3} - I_{N2N3} \cdot Z_{T2}$ $|V_{T2}| = 2439.4506$ $\frac{\arg(V_{T2})}{\text{deg}} = -1.0341$

$V_{lowT2} := V_{T2} \cdot \left(\frac{V_{low}}{kV_{hi} \cdot 1000} \right)$ $|V_{lowT2}| = 243.9451$

Problem 2.4

$V_{N1} := 2500 \cdot e^{j \cdot 0deg}$ $pf := .95$ $kVA_{T1} := 25$ $kVA_{T2} := 37.5$ $kV_{hi} := 2.4$ $V_{low} := 240$

$z_{line} := 0.306 + 0.6272j$ $zpu_{T1} := 0.018 \cdot e^{j \cdot 40deg}$ $zpu_{T2} := 0.02 \cdot e^{j \cdot 50deg}$

$D_{N1N2} := 5000$ $D_{N2N3} := 2500$

$Z_{baseT1} := \frac{kV_{hi}^2 \cdot 1000}{kVA_{T1}}$ $Z_{baseT1} = 230.4000$

$Z_{T1} := zpu_{T1} \cdot Z_{baseT1}$ $Z_{T1} = 3.1769 + 2.6658j$

$Z_{baseT2} := \frac{kV_{hi}^2 \cdot 1000}{kVA_{T2}}$ $Z_{baseT2} = 153.6000$

$Z_{T2} := zpu_{T2} \cdot Z_{baseT2}$ $Z_{T2} = 1.9746 + 2.3533j$

$z_{N1N2} := z_{line} \cdot \frac{D_{N1N2}}{5280}$ $z_{N1N2} = 0.2898 + 0.5939j$

$z_{N2N3} := z_{line} \cdot \frac{D_{N2N3}}{5280}$ $z_{N2N3} = 0.1449 + 0.2970j$

$kWDemand_{N1} := 72.43$ $pf := 0.95$

$kVA_{T1} := 25$ $kVA_{T2} := 37.5$

$kVADemand_{N1} := \frac{kWDemand_{N1}}{pf} \cdot e^{j \cdot acos(pf)}$ $|kVADemand_{N1}| = 76.2421$ $\frac{\arg(kVADemand_{N1})}{\text{deg}} = 18.1949$

$kVA_{total} := kVA_{T1} + kVA_{T2}$

$AF := \frac{kWDemand_{N1}}{kVA_{total}}$

$AF = 1.1589$

$kWDemand_{T1} := AF \cdot kVA_{T1}$ $kWDemand_{T1} = 28.9720$

$kWDemand_{T2} := AF \cdot kVA_{T2}$ $kWDemand_{T2} = 43.4580$

$kVADemand_{T1} := \frac{kWDemand_{T1}}{pf} \cdot e^{j \cdot (acos(pf))}$ $\left|kVADemand_{T1}\right| = 30.4968$ $\frac{arg(kVADemand_{T1})}{deg} = 18.1949$

$kVADemand_{T2} := \frac{kWDemand_{T2}}{pf} \cdot e^{j \cdot (acos(pf))}$ $\left|kVADemand_{T2}\right| = 45.7453$ $\frac{arg(kVADemand_{T2})}{deg} = 18.1949$

Note: For all segment and transformer currents, for the constant current model the allocated kVA will be used along with the Node N1 voltage to compute the currents.

$I_{N1N2} := \frac{\overline{kVADemand_{N1}}}{\frac{V_{N1}}{1000}}$ $\left|I_{N1N2}\right| = 30.4968$ $\frac{arg(I_{N1N2})}{deg} = -18.1949$

$V_{N2} := V_{N1} - z_{N1N2} \cdot I_{N1N2}$ $\left|V_{N2}\right| = 2485.9908$ $\frac{arg(V_{N2})}{deg} = -0.3330$

$I_{T1} := \frac{\overline{kVADemand_{T1}}}{\frac{V_{N1}}{1000}}$ $\left|I_{T1}\right| = 12.1987$ $\frac{arg(I_{T1})}{deg} = -18.1949$

$V_{T1} := V_{N2} - I_{T1} \cdot Z_{T1}$ $\left|V_{T1}\right| = 2439.2044$ $\frac{arg(V_{T1})}{deg} = -0.7808$

$V_{lowT1} := V_{T1} \cdot \left(\frac{V_{low}}{kV_{hi} \cdot 1000}\right)$ $\left|V_{lowT1}\right| = 243.9204$ $\frac{arg(V_{lowT1})}{deg} = -0.7808$

$kVADemand_{N2} := kVADemand_{T2}$ $\left|kVADemand_{N2}\right| = 45.7453$ $\frac{arg(kVADemand_{N2})}{deg} = 18.1949$

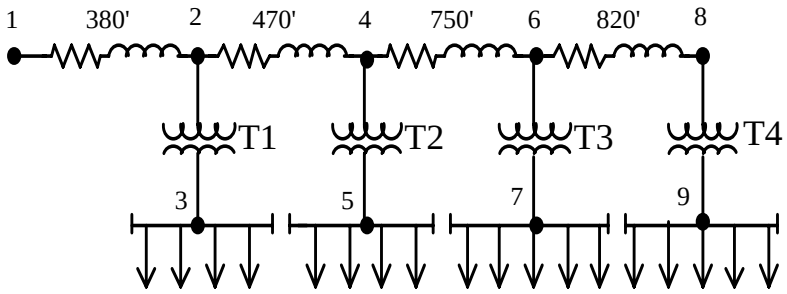
$I_{N2N3} := \frac{\overline{kVADemand_{N2}}}{\frac{V_{N1}}{1000}}$ $\left|I_{N2N3}\right| = 18.2981$ $\frac{arg(I_{N2N3})}{deg} = -18.1949$

$V_{N3} := V_{N2} - z_{N2N3} \cdot I_{N2N3}$ $\left|V_{N3}\right| = 2481.8046$ $\frac{arg(V_{N3})}{deg} = -0.4336$

$V_{T2} := V_{N3} - I_{N2N3} \cdot Z_{T2}$ $\left|V_{T2}\right| = 2434.4435$ $\frac{arg(V_{T2})}{deg} = -1.1394$

$V_{lowT2} := V_{T2} \cdot \left(\frac{V_{low}}{kV_{hi} \cdot 1000}\right)$ $\left|V_{lowT2}\right| = 243.4443$

Problem 2.5



$CustMaxDem := 15.5 + 7.5j$

$V_{N1} := 2600 \cdot e^{j \cdot 0deg}$ $\quad pf := .95$

$z_{line} := 0.4421 + 0.3213j$

$kVA_{T1} := 37.5$ $\quad kVA_{T2} := kVA_{T1}$ $\quad kVA_{T3} := 50$ $\quad kVA_{T4} := kVA_{T3}$

$zpu_{T1} := 0.01 + 0.03j$ $\quad zpu_{T2} := zpu_{T1}$ $\quad zpu_{T3} := 0.015 + 0.035j$ $\quad zpu_{T4} := zpu_{T3}$

$kV_{hi} := 2.4$ $\quad V_{low} := 240$

$DF_4 := 2.1$ $\quad DF_5 := 2.2$ $\quad DF_{10} := 2.65$ $\quad DF_{14} := 2.78$ $\quad DF_{18} := 2.86$

Problem 2.5.a

$$kVADemand_{T1} := \frac{4 \cdot CustMaxDem}{DF_4} \qquad kVADemand_{T1} = 29.5238 + 14.2857j$$

$$kVADemand_{T2} := \frac{4 \cdot CustMaxDem}{DF_4} \qquad kVADemand_{T2} = 29.5238 + 14.2857j$$

$$kVADemand_{T3} := \frac{5 \cdot CustMaxDem}{DF_5} \qquad kVADemand_{T3} = 35.2273 + 17.0455j$$

$$kVADemand_{T4} := \frac{5 \cdot CustMaxDem}{DF_5} \qquad kVADemand_{T4} = 35.2273 + 17.0455j$$

Problem 2.5.b

$$kVADemand_{N1N2} := \frac{18 \cdot CustMaxDem}{DF_{18}} \qquad kVADemand_{N1N2} = 97.5524 + 47.2028j$$

$$kVADemand_{N2N4} := \frac{14 \cdot CustMaxDem}{DF_{14}} \qquad kVADemand_{N2N4} = 78.0576 + 37.7698j$$

$$kVADemand_{N4N6} := \frac{10 \cdot CustMaxDem}{DF_{10}} \qquad kVADemand_{N4N6} = 58.4906 + 28.3019j$$

$$kVADemand_{N6N8} := \frac{5 \cdot CustMaxDem}{DF_5} \qquad kVADemand_{N6N8} = 35.2273 + 17.0455j$$

Problem 2.5.c

$D_{N1N2} := 380$ $D_{N2N4} := 470$ $D_{N4N6} := 750$ $D_{N6N8} := 820$

$z_{N1N2} := z_{line} \cdot \frac{D_{N1N2}}{1000}$ $z_{N1N2} = 0.1680 + 0.1221j$ $z_{N2N4} := z_{line} \cdot \frac{D_{N2N4}}{1000}$ $z_{N2N4} = 0.2078 + 0.1510j$

$z_{N4N6} := z_{line} \cdot \frac{D_{N4N6}}{1000}$ $z_{N4N6} = 0.3316 + 0.2410j$ $z_{N6N8} := z_{line} \cdot \frac{D_{N6N8}}{1000}$ $z_{N6N8} = 0.3625 + 0.2635j$

$Z_{baseT1} := \frac{kV_{hi}^2 \cdot 1000}{kVA_{T1}}$ $Z_{baseT1} = 153.6000$ $Z_{baseT3} := \frac{kV_{hi}^2 \cdot 1000}{kVA_{T3}}$ $Z_{baseT3} = 115.2000$

$Z_{T1} := zpu_{T1} \cdot Z_{baseT1}$ $Z_{T1} = 1.5360 + 4.6080j$ $Z_{T3} := zpu_{T3} \cdot Z_{baseT3}$ $Z_{T3} = 1.7280 + 4.0320j$

$Z_{baseT2} := \frac{kV_{hi}^2 \cdot 1000}{kVA_{T2}}$ $Z_{baseT2} = 153.6000$ $Z_{baseT4} := \frac{kV_{hi}^2 \cdot 1000}{kVA_{T4}}$ $Z_{baseT4} = 115.2000$

$Z_{T2} := zpu_{T2} \cdot Z_{baseT2}$ $Z_{T2} = 1.5360 + 4.6080j$ $Z_{T4} := zpu_{T4} \cdot Z_{baseT4}$ $Z_{T4} = 1.7280 + 4.0320j$

$I_{N1N2} := \frac{\overline{kVADemand_{N1N2}}}{\frac{V_{N1}}{1000}}$ $|I_{N1N2}| = 41.6817$ $\frac{arg(I_{N1N2})}{deg} = -25.8210$

$V_{N2} := V_{N1} - z_{N1N2} \cdot I_{N1N2}$ $|V_{N2}| = 2591.4805$ $\frac{arg(V_{N2})}{deg} = -0.0338$

$I_{T1} := \frac{\overline{kVADemand_{T1}}}{\frac{V_{N2}}{1000}}$ $|I_{T1}| = 12.6563$ $\frac{arg(I_{T1})}{deg} = -25.7871$

$V_{T1} := V_{N2} - I_{T1} \cdot Z_{T1}$ $|V_{T1}| = 2549.0127$ $\frac{arg(V_{T1})}{deg} = -1.0247$

$V_{N3} := V_{T1} \cdot \left(\frac{V_{low}}{kV_{hi} \cdot 1000} \right)$ $|V_{N3}| = 254.9013$ $\frac{arg(V_{N3})}{deg} = -1.0247$

$I_{N2N4} := \frac{\overline{kVADemand_{N2N4}}}{\frac{V_{N2}}{1000}}$ $|I_{N2N4}| = 33.4617$ $\frac{arg(I_{N2N4})}{deg} = -25.8548$

$V_{N4} := V_{N2} - z_{N2N4} \cdot I_{N2N4}$ $|V_{N4}| = 2583.0213$ $\frac{arg(V_{N4})}{deg} = -0.0676$

$$I_{T2} := \frac{\overline{kVADemand_{T2}}}{\frac{V_{N4}}{1000}} \qquad |I_{T2}| = 12.6977 \qquad \frac{\arg(I_{T2})}{deg} = -25.7534$$

$$V_{T2} := V_{N4} - I_{T2} \cdot Z_{T2} \qquad |V_{T2}| = 2540.4700 \qquad \frac{\arg(V_{T2})}{deg} = -1.0662$$

$$V_{N5} := V_{T2} \cdot \left(\frac{V_{low}}{kV_{hi} \cdot 1000} \right) \qquad |V_{N5}| = 254.0470 \qquad \frac{\arg(V_{N5})}{deg} = -1.0662$$

$$I_{N4N6} := \frac{\overline{kVADemand_{N4N6}}}{\frac{V_{N4}}{1000}} \qquad |I_{N4N6}| = 25.1558 \qquad \frac{\arg(I_{N4N6})}{deg} = -25.8886$$

$$V_{N6} := V_{N4} - z_{N4N6} \cdot I_{N4N6} \qquad |V_{N6}| = 2572.8734 \qquad \frac{\arg(V_{N6})}{deg} = -0.1082$$

$$I_{T3} := \frac{\overline{kVADemand_{T3}}}{\frac{V_{N6}}{1000}} \qquad |I_{T3}| = 15.2104 \qquad \frac{\arg(I_{T3})}{deg} = -25.7128$$

$$V_{T3} := V_{N6} - I_{T3} \cdot Z_{T3} \qquad |V_{T3}| = 2523.0500 \qquad \frac{\arg(V_{T3})}{deg} = -1.1062$$

$$V_{N7} := V_{T3} \cdot \left(\frac{V_{low}}{kV_{hi} \cdot 1000} \right) \qquad |V_{N7}| = 252.3050 \qquad \frac{\arg(V_{N7})}{deg} = -1.1062$$

$$I_{N6N8} := \frac{\overline{kVADemand_{N6N8}}}{\frac{V_{N6}}{1000}} \qquad |I_{N6N8}| = 15.2104 \qquad \frac{\arg(I_{N6N8})}{deg} = -25.9292$$

$$V_{N8} := V_{N6} - z_{N6N8} \cdot I_{N6N8} \qquad |V_{N8}| = 2566.1646 \qquad \frac{\arg(V_{N8})}{deg} = -0.1351$$

$$I_{T4} := I_{N6N8} \qquad |I_{T4}| = 15.2104 \qquad \frac{\arg(I_{T4})}{deg} = -25.9292$$

$$V_{T4} := V_{N8} - I_{T4} \cdot Z_{T4} \qquad |V_{T4}| = 2516.1944 \qquad \frac{\arg(V_{T4})}{deg} = -1.1321$$

$$V_{N9} := V_{T4} \cdot \left(\frac{V_{low}}{kV_{hi} \cdot 1000} \right) \qquad |V_{N9}| = 251.6194 \qquad \frac{\arg(V_{N9})}{deg} = -1.1321$$

Definitions for Part 7

$P3_{N2} := V_{N2}$ $P3_{N4} := V_{N4}$ $P3_{N6} := V_{N6}$ $P3_{N8} := V_{N8}$

$P3_{N3} := V_{N3}$ $P3_{N5} := V_{N5}$ $P3_{N7} := V_{N7}$ $P3_{N9} := V_{N9}$

Problem 2.5.d

$kVADemand_{N1N2} = 97.5524 + 47.2028j$

$MaxDivDemand := \frac{kVADemand_{N1N2}}{18}$ $MaxDivDemand = 5.4196 + 2.6224j$

$kVADemand_{N2N4} := MaxDivDemand \cdot 14$ $kVADemand_{T1} := 4 \cdot MaxDivDemand$

$kVADemand_{N4N6} := MaxDivDemand \cdot 10$ $kVADemand_{T2} := 4 \cdot MaxDivDemand$

$kVADemand_{N6N8} := MaxDivDemand \cdot 5$ $kVADemand_{T3} := 5 \cdot MaxDivDemand$

$I_{N1N2} := \overline{\frac{kVADemand_{N1N2}}{\frac{V_{N1}}{1000}}}$ $|I_{N1N2}| = 41.6817$ $\frac{arg(I_{N1N2})}{deg} = -25.8210$

$V_{N2} := V_{N1} - z_{N1N2} \cdot I_{N1N2}$ $|V_{N2}| = 2591.4805$ $\frac{arg(V_{N2})}{deg} = -0.0338$

$I_{T1} := \overline{\frac{kVADemand_{T1}}{\frac{V_{N2}}{1000}}}$ $|I_{T1}| = 9.2931$ $\frac{arg(I_{T1})}{deg} = -25.7871$

$V_{T1} := V_{N2} - I_{T1} \cdot Z_{T1}$ $|V_{T1}| = 2560.2226$ $\frac{arg(V_{T1})}{deg} = -0.7582$

$V_{N3} := V_{T1} \cdot \left(\frac{V_{low}}{kV_{hi} \cdot 1000} \right)$ $|V_{N3}| = 256.0223$ $\frac{arg(V_{N3})}{deg} = -0.7582$

$I_{N2N4} := \overline{\frac{kVADemand_{N2N4}}{\frac{V_{N2}}{1000}}}$ $|I_{N2N4}| = 32.5257$ $\frac{arg(I_{N2N4})}{deg} = -25.8548$

$V_{N4} := V_{N2} - z_{N2N4} \cdot I_{N2N4}$ $|V_{N4}| = 2583.2579$ $\frac{arg(V_{N4})}{deg} = -0.0666$

$I_{T2} := \overline{\frac{kVADemand_{T2}}{\frac{V_{N4}}{1000}}}$ $|I_{T2}| = 9.3226$ $\frac{arg(I_{T2})}{deg} = -25.7544$

$V_{T2} := V_{N4} - I_{T2} \cdot Z_{T2}$ $|V_{T2}| = 2551.9395$ $\frac{arg(V_{T2})}{deg} = -0.7965$

$V_{N5} := V_{T2} \cdot \left(\frac{V_{low}}{kV_{hi} \cdot 1000} \right)$ $|V_{N5}| = 255.1939$ $\frac{\arg(V_{N5})}{deg} = -0.7965$

$I_{N4N6} := \overline{\frac{kVADemand_{N4N6}}{\frac{V_{N4}}{1000}}}$ $|I_{N4N6}| = 23.3066$ $\frac{\arg(I_{N4N6})}{deg} = -25.8876$

$V_{N6} := V_{N4} - z_{N4N6} \cdot I_{N4N6}$ $|V_{N6}| = 2573.8559$ $\frac{\arg(V_{N6})}{deg} = -0.1042$

$I_{T3} := \overline{\frac{kVADemand_{T3}}{\frac{V_{N6}}{1000}}}$ $|I_{T3}| = 11.6959$ $\frac{\arg(I_{T3})}{deg} = -25.7168$

$V_{T3} := V_{N6} - I_{T3} \cdot Z_{T3}$ $|V_{T3}| = 2535.4711$ $\frac{\arg(V_{T3})}{deg} = -0.8678$

$V_{N7} := V_{T3} \cdot \left(\frac{V_{low}}{kV_{hi} \cdot 1000} \right)$ $|V_{N7}| = 253.5471$ $\frac{\arg(V_{N7})}{deg} = -0.8678$

$I_{N6N8} := \overline{\frac{kVADemand_{N6N8}}{\frac{V_{N6}}{1000}}}$ $|I_{N6N8}| = 11.6959$ $\frac{\arg(I_{N6N8})}{deg} = -25.9252$

$V_{N8} := V_{N6} - z_{N6N8} \cdot I_{N6N8}$ $|V_{N8}| = 2568.6973$ $\frac{\arg(V_{N8})}{deg} = -0.1249$

$I_{T4} := I_{N6N8}$ $|I_{T4}| = 11.6959$ $\frac{\arg(I_{T4})}{deg} = -25.9252$

$V_{T4} := V_{N8} - I_{T4} \cdot Z_{T4}$ $|V_{T4}| = 2530.2006$ $\frac{\arg(V_{T4})}{deg} = -0.8872$

$V_{N9} := V_{T4} \cdot \left(\frac{V_{low}}{kV_{hi} \cdot 1000} \right)$ $|V_{N9}| = 253.0201$ $\frac{\arg(V_{N9})}{deg} = -0.8872$

Definitions for Part 7

$P4_{N2} := V_{N2}$ $P4_{N4} := V_{N4}$ $P4_{N6} := V_{N6}$ $P4_{N8} := V_{N8}$

$P4_{N3} := V_{N3}$ $P4_{N5} := V_{N5}$ $P4_{N7} := V_{N7}$ $P4_{N9} := V_{N9}$

Problem 2.5.e

$I_{Cust} := \frac{I_{N1N2}}{18}$ $I_{Cust} = 2.0845 - 1.0086j$

$I_{N2N4} := I_{Cust} \cdot 14$ $I_{N2N4} = 29.1824 - 14.1205j$

$I_{N4N6} := I_{Cust} \cdot 10$ $I_{N4N6} = 20.8445 - 10.0861j$

$I_{N6N8} := I_{Cust} \cdot 5$ $I_{N6N8} = 10.4223 - 5.0430j$

$I_{T1} := I_{Cust} \cdot 4$ $I_{T1} = 8.3378 - 4.0344j$

$I_{T2} := I_{Cust} \cdot 4$ $I_{T2} = 8.3378 - 4.0344j$

$I_{T3} := I_{Cust} \cdot 5$ $I_{T3} = 10.4223 - 5.0430j$

$I_{T4} := I_{Cust} \cdot 5$ $I_{T4} = 10.4223 - 5.0430j$

$V_{N2} := V_{N1} - z_{N1N2} \cdot I_{N1N2}$	$\lvert V_{N2} \rvert = 2591.4805$	$\frac{\arg(V_{N2})}{\text{deg}} = -0.0338$
$V_{T1} := V_{N2} - I_{T1} \cdot Z_{T1}$	$\lvert V_{T1} \rvert =$ ▮	$\frac{\arg(V_{T1})}{\text{deg}} = -0.7554$
$V_{N3} := V_{T1} \cdot \left(\frac{V_{low}}{kV_{hi} \cdot 1000} \right)$	$\lvert V_{N3} \rvert = 256.0305$	$\frac{\arg(V_{N3})}{\text{deg}} = -0.7554$
$V_{N4} := V_{N2} - z_{N2N4} \cdot I_{N2N4}$	$\lvert V_{N4} \rvert = 2583.2858$	$\frac{\arg(V_{N4})}{\text{deg}} = -0.0666$
$V_{T2} := V_{N4} - I_{T2} \cdot Z_{T2}$	$\lvert V_{T2} \rvert = 2552.1296$	$\frac{\arg(V_{T2})}{\text{deg}} = -0.7909$
$V_{N5} := V_{T2} \cdot \left(\frac{V_{low}}{kV_{hi} \cdot 1000} \right)$	$\lvert V_{N5} \rvert = 255.2130$	$\frac{\arg(V_{N5})}{\text{deg}} = -0.7909$
$V_{N6} := V_{N4} - z_{N4N6} \cdot I_{N4N6}$	$\lvert V_{N6} \rvert = 2573.9463$	$\frac{\arg(V_{N6})}{\text{deg}} = -0.1042$
$V_{T3} := V_{N6} - I_{T3} \cdot Z_{T3}$	$\lvert V_{T3} \rvert = 2535.8834$	$\frac{\arg(V_{T3})}{\text{deg}} = -0.8584$
$V_{N7} := V_{T3} \cdot \left(\frac{V_{low}}{kV_{hi} \cdot 1000} \right)$	$\lvert V_{N7} \rvert = 253.5883$	$\frac{\arg(V_{N7})}{\text{deg}} = -0.8584$
$V_{N8} := V_{N6} - z_{N6N8} \cdot I_{N6N8}$	$\lvert V_{N8} \rvert = 2568.8411$	$\frac{\arg(V_{N8})}{\text{deg}} = -0.1249$
$V_{T4} := V_{N8} - I_{T4} \cdot Z_{T4}$	$\lvert V_{T4} \rvert = 2530.7909$	$\frac{\arg(V_{T4})}{\text{deg}} = -0.8809$
$V_{N9} := V_{T4} \cdot \left(\frac{V_{low}}{kV_{hi} \cdot 1000} \right)$	$\lvert V_{N9} \rvert = 253.0791$	$\frac{\arg(V_{N9})}{\text{deg}} = -0.8809$

Definitions for Part 7

$P5_{N2} := V_{N2}$ $P5_{N4} := V_{N4}$ $P5_{N6} := V_{N6}$ $P5_{N8} := V_{N8}$

$P5_{N3} := V_{N3}$ $P5_{N5} := V_{N5}$ $P5_{N7} := V_{N7}$ $P5_{N9} := V_{N9}$

Problem 2.5.f

$AF := \frac{kVADemand_{N1N2}}{175}$ $AF = 0.5574 + 0.2697j$

$kVADemand_{T1} := kVA_{T1} \cdot AF$ $kVADemand_{T1} = 20.9041 + 10.1149j$

$kVADemand_{T2} := kVA_{T2} \cdot AF$ $kVADemand_{T2} = 20.9041 + 10.1149j$

$kVADemand_{T3} := kVA_{T3} \cdot AF$ $kVADemand_{T3} = 27.8721 + 13.4865j$

$kVADemand_{T4} := kVA_{T4} \cdot AF$ $kVADemand_{T4} = 27.8721 + 13.4865j$

$kVADemand_{N2N4} := kVADemand_{T2} + kVADemand_{T3} + kVADemand_{T4}$

$kVADemand_{N4N6} := kVADemand_{T3} + kVADemand_{T4}$

$kVADemand_{N6N8} := kVADemand_{T4}$

$I_{N1N2} := \frac{\overline{kVADemand_{N1N2}}}{\frac{V_{N1}}{1000}}$ $|I_{N1N2}| = 41.6817$ $\frac{arg(I_{N1N2})}{deg} = -25.8210$

$V_{N2} := V_{N1} - z_{N1N2} \cdot I_{N1N2}$ $|V_{N2}| = 2591.4805$ $\frac{arg(V_{N2})}{deg} = -0.0338$

$I_{T1} := \frac{\overline{kVADemand_{T1}}}{\frac{V_{N2}}{1000}}$ $|I_{T1}| = 8.9612$ $\frac{arg(I_{T1})}{deg} = -25.7871$

$V_{T1} := V_{N2} - I_{T1} \cdot Z_{T1}$ $|V_{T1}| = 2561.3318$ $\frac{arg(V_{T1})}{deg} = -0.7320$

$V_{N3} := V_{T1} \cdot \left(\frac{V_{low}}{kV_{hi} \cdot 1000} \right)$ $|V_{N3}| = 256.1332$ $\frac{arg(V_{N3})}{deg} = -0.7320$

$I_{N2N4} := \frac{\overline{kVADemand_{N2N4}}}{\frac{V_{N2}}{1000}}$ $|I_{N2N4}| = 32.8576$ $\frac{arg(I_{N2N4})}{deg} = -25.8548$

$V_{N4} := V_{N2} - z_{N2N4} \cdot I_{N2N4}$ $|V_{N4}| = 2583.1740$ $\frac{arg(V_{N4})}{deg} = -0.0670$

$I_{T2} := \dfrac{\overline{kVADemand_{T2}}}{\dfrac{V_{N4}}{1000}}$ $\quad |I_{T2}| = 8.9900$ $\quad \dfrac{\arg(I_{T2})}{deg} = -25.7540$

$V_{T2} := V_{N4} - I_{T2} \cdot Z_{T2}$ $\quad |V_{T2}| = 2552.9663$ $\quad \dfrac{\arg(V_{T2})}{deg} = -0.7705$

$V_{N5} := V_{T2} \cdot \left(\dfrac{V_{low}}{kV_{hi} \cdot 1000} \right)$ $\quad |V_{N5}| = 255.2966$ $\quad \dfrac{\arg(V_{N5})}{deg} = -0.7705$

$I_{N4N6} := \dfrac{\overline{kVADemand_{N4N6}}}{\dfrac{V_{N4}}{1000}}$ $\quad |I_{N4N6}| = 23.9733$ $\quad \dfrac{\arg(I_{N4N6})}{deg} = -25.8880$

$V_{N6} := V_{N4} - z_{N4N6} \cdot I_{N4N6}$ $\quad |V_{N6}| = 2573.5031$ $\quad \dfrac{\arg(V_{N6})}{deg} = -0.1057$

$I_{T3} := \dfrac{\overline{kVADemand_{T3}}}{\dfrac{V_{N6}}{1000}}$ $\quad |I_{T3}| = 12.0317$ $\quad \dfrac{\arg(I_{T3})}{deg} = -25.7153$

$V_{T3} := V_{N6} - I_{T3} \cdot Z_{T3}$ $\quad |V_{T3}| = 2534.0247$ $\quad \dfrac{\arg(V_{T3})}{deg} = -0.8916$

$V_{N7} := V_{T3} \cdot \left(\dfrac{V_{low}}{kV_{hi} \cdot 1000} \right)$ $\quad |V_{N7}| = 253.4025$ $\quad \dfrac{\arg(V_{N7})}{deg} = -0.8916$

$I_{N6N8} := \dfrac{\overline{kVADemand_{N6N8}}}{\dfrac{V_{N6}}{1000}}$ $\quad |I_{N6N8}| = 12.0317$ $\quad \dfrac{\arg(I_{N6N8})}{deg} = -25.9266$

$V_{N8} := V_{N6} - z_{N6N8} \cdot I_{N6N8}$ $\quad |V_{N8}| = 2568.1963$ $\quad \dfrac{\arg(V_{N8})}{deg} = -0.1269$

$I_{T4} := I_{N6N8}$ $\quad |I_{T4}| = 12.0317$ $\quad \dfrac{\arg(I_{T4})}{deg} = -25.9266$

$V_{T4} := V_{N8} - I_{T4} \cdot Z_{T4}$ $\quad |V_{T4}| = 2528.6015$ $\quad \dfrac{\arg(V_{T4})}{deg} = -0.9116$

$V_{N9} := V_{T4} \cdot \left(\dfrac{V_{low}}{kV_{hi} \cdot 1000} \right)$ $\quad |V_{N9}| = 252.8602$ $\quad \dfrac{\arg(V_{N9})}{deg} = -0.9116$

Definitions for Part g

$P6_{N2} := V_{N2}$ $\quad P6_{N4} := V_{N4}$ $\quad P6_{N6} := V_{N6}$ $\quad P6_{N8} := V_{N8}$

$P6_{N3} := V_{N3}$ $P6_{N5} := V_{N5}$ $P6_{N7} := V_{N7}$ $P6_{N9} := V_{N9}$

Problem 2.5.g

$$\%DiffN2_4 := \frac{|P4_{N2}| - |P3_{N2}|}{|P3_{N2}|} \cdot 100 \qquad \%DiffN2_5 := \frac{|P5_{N2}| - |P3_{N2}|}{|P3_{N2}|} \cdot 100 \qquad \%DiffN2_6 := \frac{|P6_{N2}| - |P3_{N2}|}{|P3_{N2}|} \cdot 100$$

$$\%DiffN3_4 := \frac{|P4_{N3}| - |P3_{N3}|}{|P3_{N3}|} \cdot 100 \qquad \%DiffN3_5 := \frac{|P5_{N3}| - |P3_{N3}|}{|P3_{N3}|} \cdot 100 \qquad \%DiffN3_6 := \frac{|P6_{N3}| - |P3_{N3}|}{|P3_{N3}|} \cdot 100$$

$$\%DiffN4_4 := \frac{|P4_{N4}| - |P3_{N4}|}{|P3_{N4}|} \cdot 100 \qquad \%DiffN4_5 := \frac{|P5_{N4}| - |P3_{N4}|}{|P3_{N4}|} \cdot 100 \qquad \%DiffN4_6 := \frac{|P6_{N4}| - |P3_{N4}|}{|P3_{N4}|} \cdot 100$$

$$\%DiffN5_4 := \frac{|P4_{N5}| - |P3_{N5}|}{|P3_{N5}|} \cdot 100 \qquad \%DiffN5_5 := \frac{|P5_{N5}| - |P3_{N5}|}{|P3_{N5}|} \cdot 100 \qquad \%DiffN5_6 := \frac{|P6_{N5}| - |P3_{N5}|}{|P3_{N5}|} \cdot 100$$

$$\%DiffN6_4 := \frac{|P4_{N6}| - |P3_{N6}|}{|P3_{N6}|} \cdot 100 \qquad \%DiffN6_5 := \frac{|P5_{N6}| - |P3_{N6}|}{|P3_{N6}|} \cdot 100 \qquad \%DiffN6_6 := \frac{|P6_{N6}| - |P3_{N6}|}{|P3_{N6}|} \cdot 100$$

$$\%DiffN7_4 := \frac{|P4_{N7}| - |P3_{N7}|}{|P3_{N7}|} \cdot 100 \qquad \%DiffN7_5 := \frac{|P5_{N7}| - |P3_{N7}|}{|P3_{N7}|} \cdot 100 \qquad \%DiffN7_6 := \frac{|P6_{N7}| - |P3_{N7}|}{|P3_{N7}|} \cdot 100$$

$$\%DiffN8_4 := \frac{|P4_{N8}| - |P3_{N8}|}{|P3_{N8}|} \cdot 100 \qquad \%DiffN8_5 := \frac{|P5_{N8}| - |P3_{N8}|}{|P3_{N8}|} \cdot 100 \qquad \%DiffN8_6 := \frac{|P6_{N8}| - |P3_{N8}|}{|P3_{N8}|} \cdot 100$$

$$\%DiffN9_4 := \frac{|P4_{N9}| - |P3_{N9}|}{|P3_{N9}|} \cdot 100 \qquad \%DiffN9_5 := \frac{|P5_{N9}| - |P3_{N9}|}{|P3_{N9}|} \cdot 100 \qquad \%DiffN9_6 := \frac{|P6_{N9}| - |P3_{N9}|}{|P3_{N9}|} \cdot 100$$

Node	Problem 4	Problem 5	Problem 6
2	$\%DiffN2_4 = 0.0000$	$\%DiffN2_5 = 0.0000$	$\%DiffN2_6 = 0.0000$
3	$\%DiffN3_4 = 0.4398$	$\%DiffN3_5 = 0.4430$	$\%DiffN3_6 = 0.4833$
4	$\%DiffN4_4 = 0.0092$	$\%DiffN4_5 = 0.0102$	$\%DiffN4_6 = 0.0059$
5	$\%DiffN5_4 = 0.4515$	$\%DiffN5_5 = 0.4590$	$\%DiffN5_6 = 0.4919$
6	$\%DiffN6_4 = 0.0382$	$\%DiffN6_5 = 0.0417$	$\%DiffN6_6 = 0.0245$

7	$\%DiffN7_4 = 0.4923$	$\%DiffN7_5 = 0.5086$	$\%DiffN7_6 = 0.4350$
8	$\%DiffN8_4 = 0.0987$	$\%DiffN8_5 = 0.1043$	$\%DiffN8_6 = 0.0792$
9	$\%DiffN9_4 = 0.5566$	$\%DiffN9_5 = 0.5801$	$\%DiffN9_6 = 0.4931$

Problem 2.1

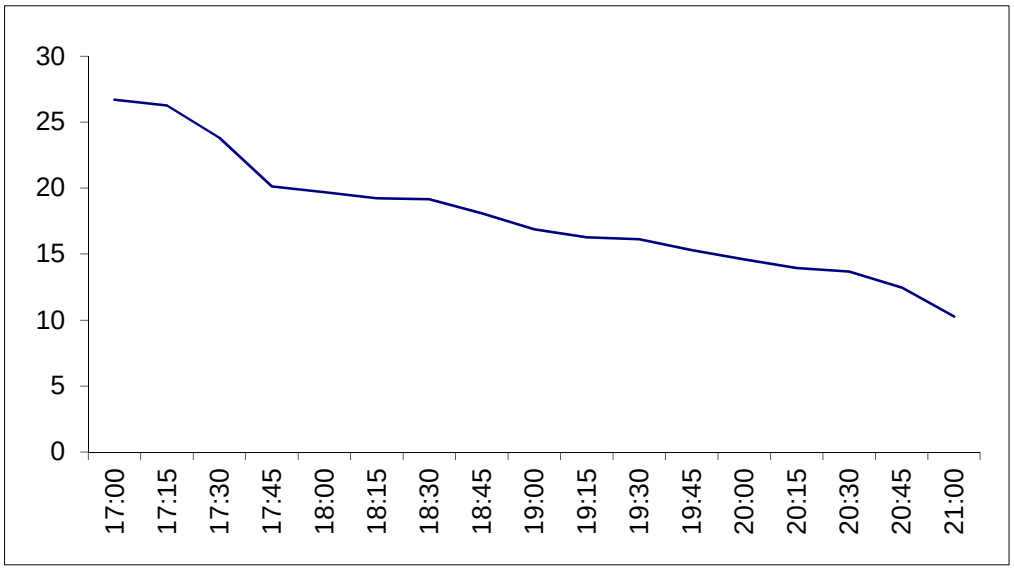
1 For each of the customers determine:

	Customer #1	Customer #2	Customer #3	Customer #4
a. Maximum 15 minute kW demand	**10.84**	**8.52**	**11.04**	**2.72**
b. Average 15 minute kW demand	**6.84**	**4.15**	**5.11**	**1.70**
c. Total KWH usage in the 4 hour period	**29.05**	**17.63**	**21.72**	**7.23**
d. Load factor	**0.6306**	**0.4867**	**0.4629**	**0.6256**

2. For the 25kVA transformer determine:

a. Maximum 15 minute diversified demand	**26.70**
b. Maximum 15 minute non-coincident demand	**33.12**
c. Utilization Factor (assume unity power factor)	**1.068**
d. Diversity Factor	**1.2404**
e. Load Diversity	**6.42**

3. Plot the "load duration curve" for the transformer



Problem 2.2

1 For each transformer determine:

	Trf #1	Trf #2
a. 30 minute maximum kVA demand	**105**	**128**
b. Non-coincident maximum kVA demand	**130.00**	**170.00**
c. Load factor	**0.595238**	**0.686523**
d. Diversity factor	**1.2381**	**1.3281**
e. Suggested transformer rating (50, 75, 100, 167)	**75**	**100**
f. Utilization factor	**1.4**	**1.2800**
g. Energy (kWh) during the 4 hour period	**225**	**316.3500**

2 Maximum diversified 30-minute kVA demand at the Tap **195**

Problem 2.3

	Cust #1	Cust #2	Cust #3	Cust #4	Cust #5	Cust #6	Cust #7	Cust #8	Cust #9	Cust #10	Cust #11	Cust #12
1. Maximum 15 minute kW demand	**3.81**	**5.81**	**4.93**	**11.26**	**6.37**	**1.56**	**1.56**	**13.48**	**1.80**	**8.97**	**8.99**	**12.23**
2. Average 15 minute kW demand	**2.45**	**1.61**	**3.59**	**9.26**	**1.56**	**0.82**	**5.15**	**0.69**	**3.34**	**5.42**	**9.06**	**2.05**
3. Total KWH usage in the time period	**10.42**	**6.85**	**15.26**	**39.36**	**6.65**	**3.47**	**21.89**	**2.92**	**14.20**	**23.05**	**38.49**	**8.71**
4. Load factor	**0.6437**	**0.2774**	**0.7284**	**0.8225**	**0.2456**	**0.5230**	**3.3017**	**0.0510**	**1.8565**	**0.6045**	**1.0073**	**0.1676**

	Trf #1	Trf #2
5. Maximum diversified demand	**22.71**	**41.56**
6. Maximum non-coincident demand	**32.18**	**48.59**
7. Utilization factor	**0.9084**	**1.1083**
8. Diversity factor	**1.4170**	**1.1692**

9. Maximum Diversified demand at N1 **57.89**